Forest Health Protection
Pacific Southwest Region

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To: Patricia Grantham, Forest Supervisor, Klamath National Forest

Subject: Happy Camp / Oak Knoll trip report

A site visit was made to the Happy Camp/Oak Knoll District, Klamath National Forest, on May 31, 2019. The site visit was centered on two events: Port-Orford-cedar (POC) mortality along Indian Creek and within the Natchez Fire Hazard Tree Abatement Project.

Background

Indian Creek

Port-Orford-cedar (*Chamaecyparis lawsoniana*) is a unique conifer growing only in southwestern Oregon and northwestern California. Port-Orford-cedar (POC) is recognized as valuable both ecologically and economically. It is adaptable to a wide variety of sites within its native range and, in some situations, may become dominate in lush riparian areas and on serpentine sites. Mature and old-growth logs command export prices many times that of most other conifers. The species also has a long list of Tribal cultural values associated with it.

On the Klamath National forest, POC grows primarily along streams and in areas with year-long seepage, usually in isolated pockets or narrow stringers confined to riparian areas. In the Indian Creek watershed, POC grows up to, and often within, the active stream channels where the large, old trees provide shade and long-lasting stream structure.

Port-Orford-cedar root disease is caused by the pathogen *Phytophthora lateralis* (PL), an oomycete. Phytophthoras exist primarily as hyphae, thin threads of fungus-like material adjacent to and within their host. Aggregations of hyphae are called mycelia. Mycelia, if fragmented, can serve to move the pathogen to new locations. Mycelia are somewhat fragile and die when exposed to drying conditions. However, there are two spore structures attached to the mycelia that are important in the spread of PL.

In the presence of free water, zoospores are released. Zoospores have flagella and although they are transported primarily by surface runoff, they can swim very short distances in saturated soil through motions of their flagella. This microscopic movement is directionally triggered by a chemical attraction to POC roots. Once they come into contact with host rootlets, they attach themselves and germinate. If a host rootlet is not encountered, they are able to form cysts that can then be carried longer distances.

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Chlamydospores, are resting spores, and are somewhat more resistant to drying and able to survive in soil and organic matter that may be moved from one place to another. They are formed inside infected roots and in the inner bark. They may persist 4-5 years in the soil without the host. Thus there are multiple ways to spread PL, which is able to survive in infected roots and root fragments for up to seven years:

1) Over long distances via chlamydospores transported in infested plant material or soil;
2) Locally via waterborne zoospores moving in ditches, streams, or in overland flow;
3) Via mycelia growing across root contacts and grafts between infected and uninfected POC.

Infection by PL is greatly favored by cool conditions and requires the presence of water around POC roots. Most POC are infected by the pathogen during the cool, wet parts of the year. High risk areas, especially favorable for the spread of PL, are low-lying wet areas that are located downslope from already infested areas.

The spores enter the tree through the soft root tips and grow through the inner bark and cambium of the root to the root collar. When all tissue in the root collar is colonized, the tree is, in effect, girdled and dies. Mortality is thought to take a few weeks for seedlings, a few months for saplings and between one to several years for large trees. Crowns of infected trees change uniformly from light green to yellow to bronze to brown.

A cinnamon-brown discoloration of the inner bark and cambium of the roots and root collar can be seen on dying trees. There is an abrupt transition between the cinnamon-brown tissue and the healthy, bright cream-colored inner bark. This stain proceeds up the stem from the roots to the root collar. The discoloration is hard to see after death because the inner bark loses its bright appearance.

I had visited Indian Creek in June of 2010 with Plant Pathologist, Pete Angwin (NC10-004). At that time there was no known PL infections along Indian Creek. To maintain that condition, roadside sanitation was recommended removing all POC, less than 12 inches DBH, 25 feet above and 50 feet below the Indian Creek Road (17N32) and the Bald Hornet Road (17N18). Where the roads crossed over streams, the recommendation along the streams increased to 100 feet below the roads. Several POC along the Indian Creek Road were tagged for genetic resistance testing by Chuck Frank, Zone Geneticist, and Roger Siemers, Klamath NF retired).

Two mature POC were reported to have died in a pull-out on the edge of the road in the spring of 2019. At the time of my visit, both trees had been dead long enough to be fully red and starting to lose foliage.

Natchez Fire

The Natchez Fire was started by lightning on July 15, 2018. The fire burned 38,134 acres between Happy Camp, CA and Cave Junction, OR before being fully contained on October 30. The fire burned in POC stands in the upper Indian Creek drainage.

Although young Port-Orford-cedar trees are easily killed by fire, relatively old trees are very fire resistant because their bark may be up to 10 inches thick. It is reported less fire resistant than Douglas-fir, Ponderosa pine, sugar pine, Jeffrey pine, and incense-cedar, but more fire resistant than true firs and hemlocks.

There are no fire marking guidelines developed for POC when the Region developed the Marking Guidelines for Fire-injured Trees of California (2011).

Observations

Indian Creek

Two dead POC were found at a wide spot in the Indian Creek Road in the spring of 2018. These trees appear to have died suddenly and changed from green to red/brown very quickly. One was approximately 24 inches in diameter and had died before the smaller 14 inch tree next to it (Figure 1). Wood borers were found under the bark of the larger tree but had not yet invaded the smaller tree. Other than PL, Port-Orford-cedar has no serious natural enemies. Cedar bark beetles and wood borers are known to attack dead, dying and stressed trees, but are not a significant impact on healthy trees. Tissue samples, bark with cambium and outer sapwood tissue attached, were taken though, due to the trees being dead for a length of time, there was no visible cinnamon-discoloration to indicate PL infection. The samples were sent to the lab at Oregon State University to test for PL from both trees. The samples have so far returned negative, but it is highly possible that a negative does not indicate PL is absent, it may mean that the trees were too long dead to get active PL from the samples. There are generally only two things that are known to kill mature POC so quickly: drought and PL. It is my opinion that even with a negative return from OSU, it is likely that these trees died from PL infection.

There is a small bench below the wide spot in the road with a stand of mature POC (Figure 2). This bench is considered a high risk site because it is a low-lying wet area located downslope from a likely infested area and a likely site for introduction (the road).

Figure 1. Two dead, mature Port-Orford-cedar trees along Indian Creek Road, Klamath National Forest.

Figure2. Small stand of Port-Orford-cedar below Indian Creek Road at site of new mortality.

The road was used heavily and dust abatement was done during the Natchez Fire. There was controversy over where to get water for firefighting and water may have been used from infected sources. There is an intermittent stream on the upstream side of the bench and no POC further downstream of the bench.

Natchez Fire

Many fire-injured and killed POC were seen in the upper reaches of Indian Creek (Figure 3) where the Natchez Fire burned through in 2018. There is currently a hazard tree removal project where the Forest is using the incense cedar guidelines, with a probability of mortality of 70% for trees less than 45 inches DBH and 90% for trees greater than 45 inches, in lieu of POC guidelines for marking.

Figure 2. Fire-injured and killed Port-Orford-cedar in upper reaches of Indian Creek. Natchez Fire burned in 2018.

Discussion

Indian Creek

I recommended a small eradication zone, remove or kill all live POC, to be implemented on the bench down to Indian Creek and within 50 feet of the intermittent stream. Because the spores persist for up to seven years in the soil and root tissue, this eradication zone would need to be monitored and maintained clear of POC for 5 years. After the 5 year period, if PL has not been detected, a continuation of the original sanitation would be recommended. I also recommended stream-baiting to monitor for PL infection within Indian Creek immediately upstream and downstream of the eradication zone. The main point of removing the POC is to protect POC downstream of the infection center.

The Indian Creek Road is within the Elk-Indian Community Wildfire Protection Project (SOPA gives decision time in 2020), a 170,000 acre fuels reduction treatment along private property egress and ingress roads, other Forest Service roads used for strategic firefighting use, and ridges. The project is located in and around the town of Happy Camp, within the watersheds of Indian Creek and Elk Creek. Project scheduling should be limited to the dry season to prevent further spread of the pathogen. Conducting work in areas where the pathogen is not present before infested areas should also be incorporated into project planning. Otherwise, the project may be a good vehicle for removing the infested and high-risk POC as long as infested trees are not yarded through non-infested areas. Infested trees would need to be yarded directly to the road to limit pathogen exposure.

Locations, such as Indian Creek Road, which receive a lot of visitor use, and which are infested with the root disease, are at high risk of infestation expanding and high rates of POC mortality. The eradication zone described above would have three main objectives:

1) To create and maintain a host-free environment in an infested area to reduce spore levels
2) To create and maintain a host-free environment in high-risk location
3) To eliminate that area as a potential source of disease spread.

While there is concern regarding movement of spores by general traffic through the forest, higher risk lies in project activities using unwashed vehicles and equipment. A large reduction in pathogen spores occurs when vehicles and equipment are washed. Washing equipment prior to working in uninfested areas or when leaving infested areas will minimize the movement of infested soil.

All of these activities should be followed with monitoring. Monitoring the eradication zone to continue to remove all POC for 5 years as well as the stream-bait monitoring will help the Forest maintain Indian Creek as uninfested. Monitoring Port-Orford-cedar has three main objectives:

1) To identify and track PL infections.
2) To determine whether or not control strategies were implemented, the effectiveness of control strategies, and areas of possible program improvement.
3) To implement forest plan monitoring direction.

According to the Klamath National Forest Forest-Wide Standards and Guidelines, management activities should be designed to maintain or increase population levels of desirable native species, such as POC. Measures taken should limit the spread of PL.

Natchez Fire

I recommended using the incense cedar guidelines for the POC hazard tree removals in the upper part of the drainage affected by the Natchez Fire. I also suggested that we could put in a validation plot monitoring the future mortality of the POC that was fire-injured. This was met with enthusiasm from the Forest staff, but postponed until the hazard abatement was completed in the area to protect folks involved with setting up the plot and being sure to remove the trees that meet the hazard tree removal guidelines. The plot will most likely be started in the fall of 2019, one year post-fire.

If you have any questions regarding this report and/or need additional information, please contact Cynthia Snyder at 530-226-2437.

/s/ Cynthia Snyder

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